VOLUME 77 SEPARATE No. D-43

PROCEEDINGS

AMERICAN SOCIETY
OF
CIVIL ENGINEERS

OCTOBER, 1951

DISCUSSION OF SETTLEMENT CORRECTION AT LA GUARDIA FIELD

(Published in November, 1950)

By D. P. Krynine, and John M. Kyle

AIR TRANSPORT DIVISION

Headquarters of the Society
33 W. 39th St.
New York 18, N.Y.

PRICE $0.50 PER COPY

GUIDEPOST FOR TECHNICAL READERS

"Proceedings-Separates" of value or significance to readers in various fields are here listed, for convenience, in terms of the Society's Technical Divisions. Where there seems to be an overlapping of interest between Divisions, the same Separate number may appear under more than one item.

Technical Division	*Proceedings-Separate Number*
Air Transport	42, 43, 48, 52, 60, 93, 94, 95 (Discussion: D-XXVIII, D-7, D-16, D-23, D-18, D-43)
City Planning	58, 60, 62, 64, 93, 94 (Discussion: D-16, D-23, D-43)
Construction	43, 50, 55, 71, 92, 94 (Discussion: D-3, D-8, D-23, D-17, D-36, D-40)
Engineering Economics	46, 47, 62, 64, 65, 68, 69, 95 (Discussion: D-2, D-19, D-27, D-30, D-36)
Engineering Mechanics	41, 49, 51, 54, 56, 59, 61, 88, 89, 96 (Discussion: D-5, D-XXIII, D-XXV, D-18, D-24, D-33, D-34)
Highway	43, 44, 48, 58, 70 (Discussion: D-XXVIII, D-7, D-16, D-23, D-13)
Hydraulics	50, 55, 56, 57, 70, 71, 78, 79, 80, 83, 86, 92, 96 (Discussion: D-XXVII, D-9, D-11, D-19, D-28, D-29)
Irrigation	46, 47, 48, 55, 56, 57, 67, 70, 71, 87, 88, 90, 91, 96 (Discussion: D-XXIII, D-3, D-7, D-11, D-19, D-25-K, D-29, D-17, D-30, D-38, D-40, D-44)
Power	48, 55, 56, 69, 71, 88, 96 (Discussion: D-XXIII, D-2 D-3, D-7, D-11, D-19, D-25-K, D-17, D-30, D-38, D-40, D-44)
Sanitary Engineering	55, 56, 87, 91, 96 (Discussion: D-10, D-29)
Soil Mechanics and Foundations	43, 44, 48, 94 (Discussion: D-4, D-XXVIII, D-7, D-43, D-44)
Structural	42, 49, 51, 53, 54, 59, 61, 66, 89 (Discussion: D-5, D-3, D-8, D-16, D-23, D-13, D-21, D-24, D-25-K, D-32, D-17, D-33, D-34, D-39, D-42)
Surveying and Mapping	50, 52, 55, 60, 63, 65, 68
Waterways	41, 44, 45, 50, 56, 57, 70, 71, 96 (Discussion: D-XXVII, D-9, D-8, D-19, D-27, D-28)

A constant effort is made to supply technical material to Society members, over the entire range of possible interest. Insofar as your specialty may be covered inadequately in the foregoing list, this fact is a gage of the need for your help toward improvement. Those who are planning papers for submission to "Proceedings-Separates" will expedite Division and Committee action measurably by first studying the ASCE "Guide for Development of Proceedings-Separates" as to style, content, and format. For a copy of this Manual, address the Manager, Technical Publications, ASCE, 33 W. 39th Street, New York 18, N. Y.

Published at Prince and Lemon Streets, Lancaster, Pa., by the American Society of Civil Engineers. Editorial and General Offices at 33 West Thirty-ninth Street, New York 18, N. Y.

DISCUSSION

D. P. KRYNINE,[7] M. ASCE.—Since the construction of La Guardia Airport (New York, N. Y.), American engineers have been extremely interested in developments at that field, especially concerning the large settlements in the area. This paper satisfies to a large degree the scientific curiosity of engineering circles, though some details require still further elucidation.

After giving some historical and geological information on the La Guardia Field area, the author presents, among other things, the following two basic items: (1) experimentation on the three large sand drain areas; and (2) construction of the dike surrounding that area of the airport in which the maximum settlement had occurred. The writer's comments refer to these two items only.

The general principle of the sand drain method consists of acceleration of the rate of settlement that may be expected due to the presence of a soft substratum. Since there is no possibility of eliminating such settlement, at least at the present (1951) state of the foundation technique, the sooner this settlement takes place, the better. With this criterion in mind the writer examined the comparative merits of different drain spacings used in the experimental areas (Segments I, II, and III). It appears from the data presented in Fig. 2 and Table 2 that during the whole time of experimentation there was a continuous lag in the behavior of Segment I with the largest drain spacing (14 ft) as compared with Segment II (11 ft drain spacing). Not only was the settlement of Segment I smaller than that of Segment II during the whole time of experimentation, but the final results differed by about 15% (6.43 ft settlement for Segment I and 7.55 ft settlement for Segment II). On the other hand, although in the first year of experimentation there was some difference in the behavior of Segments II and III (11-ft and 8-ft spacings of sand drains, respectively), close to the end of the first year this difference became negligible. The final settlement observed in Segment II was even a little larger than that in Segment III.

The writer's conclusion from the experimental results is that 14-ft spacing of drains (Segment I) under the conditions at La Guardia Field proved to be somewhat excessive, whereas the 8-ft spacing (Segment III) showed a wasteful crowding of drains. It is not clear from the paper what advantage was taken of the full-size experiment described, that is what was the actual drain spacing in the final design and construction of the dike. Another thing that interests the writer is whether some attempt was made to correlate the spacing of the drains and the results shown in Fig. 2 and Table 2 with the permeability (particularly with the ratio of the vertical and horizontal permeabilities) of the soil material or materials at La Guardia Field. Such information, if available, would be of extreme value to engineers who may find themselves facing a settlement problem similar to that described in this paper.

NOTE.—This paper by John M. Kyle was published in November, 1950, as *Proceedings-Separate No. 43*. The numbering of footnotes and illustrations in this Separate is a continuation of the consecutive numbering used in the original paper.

[7] Cons. Engr., San Francisco, Calif.

The writer hopes that in his final closure Mr. Kyle will give some additional information with reference to the questions offered in this discussion. Some numerical data on the dimensions of the drains (length, diameter) and the cross section of the dike would also be of interest.

JOHN M. KYLE[8].—The discussion by Mr. Krynine has emphasized an important point, concerning the spacing of drains, that should clarified. By examination of Fig. 2 and Table 2 only, one could conclude that the 8-ft spacing was a wasteful crowding of drains.

Because of the limited space available at the airport, it was unfortunately necessary to have the segments of the test section adjacent to each other. Fig. 3 shows the layout of the test section and the settlement curve for each segment up to April, 1951. The drains in Segment I were spaced 14 ft on

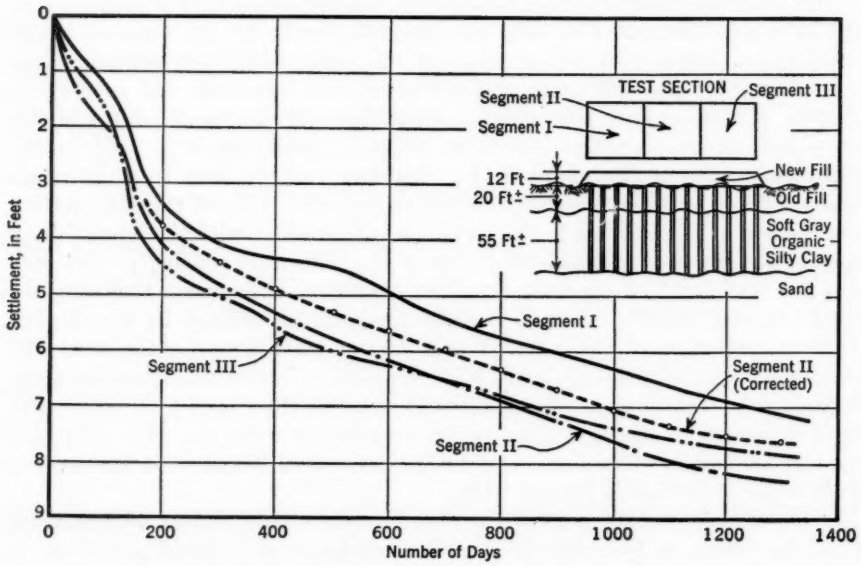

FIG. 3.—SETTLEMENT OBSERVATIONS ON SAND DRAINS FOR SUBSOIL STABILIZATION

centers. Drain spacing in Segments II and III was 11 ft and 8 ft on centers, respectively. From the layout of the test section, it can be seen that Segment II, being surrounded on each side by one of the other segments, has a greater load acting on it than either Segment I or Segment III. By correcting for this additional load, a new settlement curve can be plotted for Segment II, and this curve is shown as a dashed line in Fig. 3. This corrected curve now takes a more proper place in relation to the other curves and would tend to prove that, under the same loading conditions, a quicker rate of settlement can be achieved by a smaller spacing of drains.

[8] Chf. Engr., The Port of New York Authority, New York, N. Y.

The ratio of horizontal permeability (K_h) to vertical permeability (K_v) was constant throughout the test section area, although it differed slightly throughout the airport. Because of this, no correlation between rates of settlement of different spacings of drains and different K_h/K_v ratios could be attempted. However, based on test section results and the theory of radial drainage, it is believed that any increase in K_h/K_v ratios would result in a relative increase in the rate of settlement, and that this increase would be constant for the different spacings of sand drains.

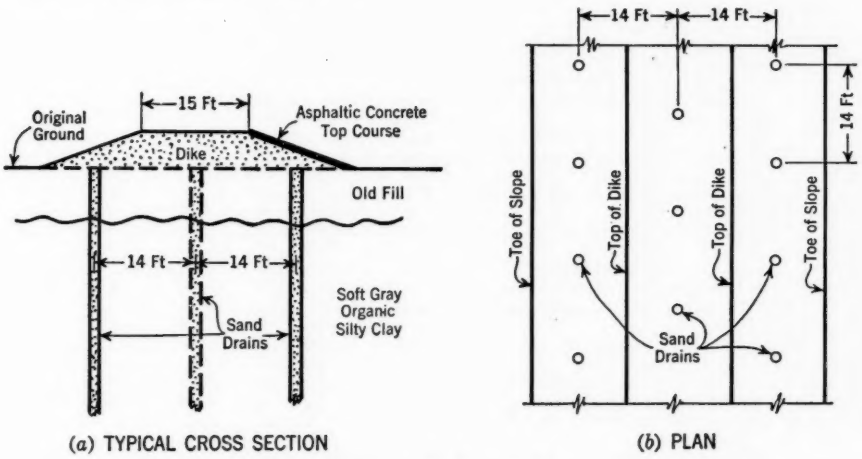

FIG. 4.—DIKE AT LA GUARDIA FIELD

Fig. 4 shows a typical cross section of the dike. Sand drains were installed in three rows at 14-ft spacing in the area to be occupied by the dike. A larger number of rows or a smaller interval of spacing of sand drains would have become unduly expensive and was not deemed necessary because of the nature and purpose of the dike. The sand drains were 18 in. in diameter and were approximately 80 ft long.

CURRENT PAPERS AND DISCUSSIONS

Proceedings-Separate Number	Date Available	Title and Author	Discussion closes
57	Mar., 1951	"Design of Irrigation Systems," by W. H. Nalder	Aug. 1
58	Mar., 1951	"Highway Planning in Turkey," by H. E. Hilts	Aug. 1
59	Mar., 1951	"Limit Design of Beams and Frames," by H. J. Greenberg and W. Prager	Aug. 1
60	Mar., 1951	"Surveying and Mapping Requirements for Modern City Planning," by Charles A. Blessing	Aug. 1
61	Apr., 1951	"Structural Damping in Suspension Bridges," by the late Friedrich Bleich and L. W. Teller	Sept. 1
62	Apr., 1951	"The New Towns Program in Great Britain," by T. C. Coote	Sept. 1
63	Apr., 1951	"National Geodesy—Status and Planning," by Leo Otis Colbert	Sept. 1
64	May, 1951	"Planning the National Capital: Objectives and Problems of Attainment," by Ulysses S. Grant, III	Oct. 1
65	May, 1951	"National Topographic Mapping," by W. E. Wrather	Oct. 1
66	May, 1951	"Lateral Forces of Earthquake and Wind," by a Joint Committee of the San Francisco, Calif., Section, ASCE, and the Structural Engineers Association of Northern California	Oct. 1
67	June, 1951	"Model and Prototype Studies of Sand Traps," by Ralph L. Parshall	Nov. 1
68	June, 1951	"International Cartography," by Robert H. Randall	Nov. 1
69	June, 1951	"Valuation and Depreciation Related to Income Tax," by Maurice R. Scharff	Nov. 1
70	June, 1951	"Regime Theory for Self-Formed Sediment-Bearing Channels," by T. Blench	Nov. 1
71	June, 1951	"Rectification of the Papaloapan River in Mexico," by Reynaldo Schega	Nov. 1
72	June, 1951	"Design of Large Coal Bunkers," by Paul Rogers	Nov. 1
73	July, 1951	"Health Implications of Air Pollution," by J. J. Bloomfield	Dec. 1
74	July, 1951	"Acceptable Standards for Natural Waters Used for Bathing," by Charles R. Cox	Dec. 1
75	July, 1951	"Base Course Drainage for Airport Pavements," by Arthur Casagrande and William L. Shannon	Dec. 1
76	July, 1951	"Model Tests Using Low-Velocity Air," by James W. Ball	Dec. 1
77	Aug., 1951	"Buckling Stresses for Flat Plates and Sections," by Elbridge Z. Stowell, George J. Heimerl, Charles Libove, and Eugene E. Lundquist	Jan. 1
78	Aug., 1951	"River Channel Roughness," by Hans A. Einstein and Nicholas L. Barbarossa	Jan. 1
79	Aug., 1951	"Stage Predictions for Flood Control Operations," by Ralph E. King	Jan. 1
80	Aug., 1951	"Mississippi River Valley Geology Relation to River Regime," by Harold N. Fisk	Jan. 1
81	Aug., 1951	"Petenwell Hydroelectric Project," by E. Montford Fucik	Jan. 1
82	Sept., 1951	"Pressures in a Shallow Rectangular Bin," by Raymond L. Moore and J. R. Shaw	Feb. 1
83	Sept., 1951	"Waterway Traffic on the Great Lakes," by John R. Hardin	Feb. 1
84	Sept., 1951	"Longitudinal Mixing Measured by Radioactive Tracers," by Harold A. Thomas, Jr., and Ralph S. Archibald	Feb. 1
85	Sept., 1951	"Resinous Ion Exchangers in Water Treatment," by William W. Aultman	Feb. 1
86	Sept., 1951	"Ground-Water Movement Controlled Through Spreading," by Paul Baumann	Feb. 1
87	Oct., 1951	"Sewage Reclamation by Spreading Basin Infiltration," by Ralph Stone and William F. Garber	Mar. 1
88	Oct., 1951	"Experimental Study of Water Flow in Annular Pipes," by W. M. Owen	Mar. 1
89	Oct., 1951	"Deflections in Gridworks and Slabs," by Walter W. Ewell, Shigeo Okubo, and Joel I. Abrams	Mar. 1
90	Nov., 1951	"Consumptive Use of Water by Forest and Range Vegetation," by L. R. Rich	Apr. 1
91	Nov., 1951	"Consumptive Use of Water," by Harry F. Blaney	Apr. 1
92	Nov., 1951	"Experimental Investigation of Fire Monitors and Nozzles," by Hunter Rouse, J. W. Howe, and D. E. Metzler	Apr. 1
93	Nov., 1951	"Aircraft Design as Related to Airport Standards," by Milton W. Arnold	Apr. 1
94	Nov., 1951	"Friendship International Airport," by Benjamin Everett Beavin	Apr. 1
95	Nov., 1951	"Directional Requirements for Airport Runways," by Ralph H. Burke and Harry Otis Wright, Jr.	Apr. 1
96	Nov., 1951	"Surface Curves for Steady Nonuniform Flow," by Robert B. Jansen	Apr. 1

AMERICAN SOCIETY OF CIVIL ENGINEERS

OFFICERS FOR 1951

PRESIDENT

GAIL A. HATHAWAY

VICE-PRESIDENTS

Term expires January, 1952:

FRED C. SCOBEY
ALBERT HAERTLEIN

Term expires October, 1952:

WILLIAM R. GLIDDEN
DANIEL V. TERRELL

DIRECTORS

Term expires January, 1952:

WALDO G. BOWMAN
HAROLD L. BLAKESLEE
PAUL L. HOLLAND
EDMUND FRIEDMAN
S. T. HARDING

Term expires January, 1953:

OTTO HOLDEN
FRANK L. WEAVER
GORDON H. BUTLER
G. BROOKS EARNEST
WALTER J. RYAN*
GEORGE W. LAMB

Term expires October, 1952:

MORRIS GOODKIND
MILTON T. WILSON

Term expires October, 1953:

KIRBY SMITH
FRANCIS S. FRIEL
LOUIS R. HOWSON
WALLACE L. CHADWICK
NORMAN R. MOORE
BURTON G. DWYRE

PAST-PRESIDENTS

Members of the Board

FRANKLIN THOMAS
ERNEST E. HOWARD

TREASURER
CHARLES E. TROUT

EXECUTIVE SECRETARY
WILLIAM N. CAREY

ASSISTANT TREASURER
GEORGE W. BURPEE

ASSISTANT SECRETARY
E. L. CHANDLER

PROCEEDINGS OF THE SOCIETY

SYDNEY WILMOT
Manager of Technical Publications

HAROLD T. LARSEN
Editor of Technical Publications

JOHN C. REHFIELD
Assoc. Editor of Technical Publications

COMMITTEE ON PUBLICATIONS

WALDO G. BOWMAN

FRANCIS S. FRIEL
S. T. HARDING
OTTO HOLDEN
LOUIS R. HOWSON
NORMAN R. MOORE

* Deceased.